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SHAVINGS EXAMINED MICROSCOPICALLY.

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THE examination of any organic tissue, be it animal or vegetable, by means of the modern achromatic microscope, reveals such a world of beauty, and so much material for wonder, that the novice in such pastime is for a while very much puzzled what to observe, and what to leave unseen. Although life, that mysterious manifestation of Divine will, appears to be most strikingly made manifest in animal existences, yet the grass of the field and wood of the oak tree present materials attractive to him who will patiently read aright the lessons they inculcate. It is my intention, in the present article, to point out to the young student of nature a path that may be traversed with great profit and lasting pleasure. I have taken as my subject the structure of wood, the hard tissue of plants, as exhibited in the shaving which the carpenter peels off with his jack-plane. Let the embryo microscopist collect a number of such, the thinner the better, and I warrant he will have enough to do when looking at them through the long winter's evenings.

All plants, it has been discovered, great and small, the monarch of the woodland and the violet of the plain; aye, all, with the exception, perhaps, of those doubtful little

organisms that puzzle and delight the students of atomies, and which are grouped under the great collective head of the *Protophyta*, are constructed after the same general plan, and consist of the same chemical substances, congregated together after similar types, varying only in degrees of complexity. And what is an equally, if not more remarkable fact, those substances which go to make up the bulk of the vegetable organism are found also in the animal, constituting the elementary components of its body likewise.

However it is not our intention, at the present time, to enter into the consideration of the chemical constitution of vegetable tissues; interesting as that branch of vegetable physiology is, we must forbear, and, assisted by the microscope, proceed to the examination of those tissues themselves. The general structure of all plants consists of a substance known to chemists under the name of cellulose, the wall-matter of cells, so to speak; cells being the most important part of plants, as we shall see presently. It is this cellulose that we are so well acquainted with under so many different forms and names and constituting vegetable fibre, bark, the great mass and harder portions of all leaves, flowers, fruit and stems; and, although in special cases we find it somewhat modified, it is always to be recognized from its possessing certain unmistakable characteristics, familiar to all in the substance of paper, and, therefore, of course, in the linen or cotton, the wood or the straw from which the paper was made, so that we say that about all the paper we see is composed of cellulose in almost a pure condition, there being but little used which is manufactured from animal tissues, such as wool and silk. The rice-paper of the Chinese is not, as is generally supposed, made of rice, but of the light and porous pith of a plant which has been cut in the form of a broad strip, around and around the mass of the tissue, as is plainly seen when a small piece is examined by means of a magnifying glass, when the little cells or cavities which made up the pith are very evident. Woody

tissue is made up for the most part of this cellulose, arranged in different forms, all, however, derivable from the simple sac or cell, which is the basis and foundation, morphologically, of the whole vegetable kingdom; being found in its simple and uncomplicated form in the *Protophyta*, or first plants, we have mentioned, and modified in outline to a greater or less degree in the different parts of the tree, stem, leaves, and flowers. There is a doubt, however, in the minds of some physiologists as to whether the hard parts of plants are made up of this substance cellulose, or a modification of it termed "lignine." This point is one which we will not consider, as it is extremely doubtful if either of these two compounds has been obtained pure and separate from the other.

If a slice be made with a very sharp knife of some ripe fruit, as an apple or an orange, it will be observed on viewing such a section by means of the microscope, that it is made up of almost symmetrical and equal sized little sacs or cells, as they are called; and such simple tissue is known as cellular tissue. But if a similar slice be made of such hard matter as wood, a very different appearance will present itself to our eyes. First, however, so as to make ourselves acquainted with the manner in which such simple cellular tissue (where the elementary sacs merely touch each other with very little mutual pressure) passes into the more complex woody tissue, take a similar slice from the stem or young rootlet of some herbaceous plant, as the garden rhubarb or other common vegetable. Such a slice, made as thin as possible, is now placed in a little water upon a glass "slide," and, with a thin "cover" over it, examined by means of a microscope which does not magnify too strongly. We now see that the tissue in this case is cellular, as well as that in the fruit, but that the individual cells have become much altered in appearance from mutual pressure, which in some cases has been equal upon all sides, in others greater in certain directions than in others. So they have been crowded

upon each other until they have lost their almost spherical outline, and flat sides have made their appearance. We may illustrate the form of vegetable cells by blowing soap-bubbles with a tube. As long as we blow but one bubble at a time, they remain spherical in form and represent the simple *Protophyta*, but if we blow one after another until a string of them remain pendant from the tube we have a representative of the slightly more complex plants growing submerged in water and known as algæ. By placing the tube beneath the surface of the soapy liquid contained in a bowl and blowing we form a number of bubbles, which, on account of their being confined within the bowl, press upon each other almost equally and become many sided. The form that thus results is found on examination to be of a more or less perfectly geometrical outline, and such a mass very strikingly represents the cellular tissue we are examining, but to make it look still more like our section, we press a glass plate down upon the mass of bubbles, and thus we have the cavities cut across. But one other fact will be noticed through the glass plate, and that is that the bubble sections are for the most part six-sided, and such is also the case with the plant cells. This is the result of cutting through the regular geometrical form always caused by the mutual equal pressure of many spheres. In honeycomb we have another illustration of this fact; there the pressure has apparently been unequal, and the cell has become elongated into a six-sided prism. A precisely similar mode of aggregation is to be observed in vegetable tissues, and may be made evident by cutting two sections at right angles to each other. Such slices are known to microscopists as longitudinal and transverse sections; the first, in the case of wood, being taken lengthwise of the stem or branch, and the other across it. As the pressure is generally very unequal, perfect forms of the cells are the exception, and therefore the variety of outline of cells in vegetable tissues is very varied, that which is hexagonal being the most common. As a plant

grows, the number of cells is multiplied, and as the growth is faster in one direction than in others the resulting cells are elongated; in fact we find in woody tissues that the so-called wood cells are more or less fibrous, so that such tissue is known as woody fibre. These wood-cells are pointed at both ends, in fact are fusiform. Some of the cells, however, become united by the absorption of their contiguous walls, so that continuous tubes are formed. These tubes are for the purpose of transporting the life-blood of the plant (the sap), which like the blood of the animal, is the source of the new tissues which are built up from its matter. As these tubes are of such importance in the economy of the individual, it becomes necessary that they should be protected from injury, and such injury is most likely to be a crushing from without and a consequent stoppage of the flow of the sap. If we were to stop the flow of the blood in the arm, for instance, by tying a ligature above the elbow, we should find that disorganization of the tissues in the fore-arm and hand would result; they would mortify and death of the parts would follow. The same thing we can readily understand would take place in the plant, should the sap-flow be arrested in any way. To prevent such a disaster these long tubes are strengthened in a very remarkable manner, namely, by having a deposit of tough lignine formed within their walls, and arranged in the form of a spiral. The same mode of structure is to be seen in the tubes called tracheæ, which convey the air to and from the lungs of animals. Insects exhibit this structure in a very striking manner; the tracheæ of a caterpillar of some kind, most commonly the silk-worm, is a favorite microscopic object. The spiral arrangement at the same time permits of a certain amount of elasticity in such vessels, as is to be seen in a very common illustration of such structure. I allude to the flexible tubing used to convey burning gas from a chandelier to a burner upon the table. Such spiral ducts, as they have been named, are to be seen in most cross

sections of wood, and in our plate are represented by the largest openings. In some of the succulent plants, however, they are to be seen in a more striking manner. It is only necessary to tear a stalk of rhubarb or celery apart to find that fine fibres appear which are the last things to be ruptured; these are the spiral ducts, and constitute the "stringiness" of old specimens of vegetables. In our wood shavings we also observe other points of interest, more especially if the sections be cut across the "grain" or direction of the main growth. First let us examine the upper of our figures (Pl. 10, fig. 1), which represents such a slice cut from a stick of oak. This has been taken from a common kind of wood and well representing the grand group of plants to which it belongs, that is to say the *Exogens*, or outside growers. Our lower figure, on the other hand, represents a section of a stem of sugar-cane, showing the mode of growth of an *Endogen*, or inside grower. And these two names at once designate the point upon which we wish to dwell; the mode of growth of woody stems as shown by means of the microscope. These figures have been carefully drawn from photographs taken for the purpose, and are, therefore correct representations of the objects. Looking now at our cross-grain shaving of oak, we notice first, scattered somewhat unevenly all over it, large openings, which are the spiral ducts; in some parts they appear to be more closely congregated together, forming, as it were, rows which are continuous after the manner of rings, increasing in dimensions from the centre of the stick towards the circumference. These show us how the wood grows. At first, when it is but a sapling, there is very little woody tissue present, as is evidenced from its fragility, and the moss of it is made up of simple cellular tissue. This constitutes the pith of the stem, and varies in dimensions in different plants; in the elder being very large, in the oak of small size. Through the large spiral ducts the sap freighted with matter for the building up of new tissues, is carried upwards to the leaves;

here it is brought in contact with the sunlight and air, and certain chemical changes take place in its composition. Downwards, through another set of ducts, it is carried just inside the bark, and here through its instrumentality, woody fibre is deposited, one fibre upon the other externally, and thus the twig grows by outside growth, becoming thicker and thicker each year. This addition of substance goes on during the spring and autumn months, the plant doing very much the same as human beings, that is to say, resting during the hot season. But when winter comes its growth is arrested entirely, and like the hibernating animals the tree sleeps. Now in animals the blood is carried by a set of vessels, known as arteries, to the lungs, where it comes in contact with the air inhaled, and has its composition so changed that it can build up new tissues. The same thing, essentially, we see, takes place in the tree, the leaves representing the lungs, or oxygenating organs. Now as the tree sleeps during the winter months here is an arrest of growth, and therefore when we examine such a cross-section of a piece of wood as we have given, we find a number—less or greater, according to the number of winters it has existed—of these rings of arrested growth, and by counting them we can arrive at the age of such a stick of wood. So we see how the microscope assists in acquiring such a knowledge; and of course we shall find similar structure in all outside growers or *Exogens*. With inside growers the case is very different; for here the new matter is not deposited externally in regular rings; and, in fact we can, from a consideration of the facts we have related, readily understand why the *Endogens* are mostly confined to such portions of the globe where there are no cold months to arrest the growth. However, even in such climates, *Exogens* grow and rest also during a part of the year. We have given the two sections represented to show the very marked difference in these two modes of growth as illustrated by microscopic sections, and those who desire to verify our illustrations can readily do so

by cutting a slice of some green stem, when the sap is in the wood and it is therefore the more readily cut, and also taking a slice of some *Endogen*, the garden asparagus being an excellent plant for that purpose, and after placing them on a glass "slide" and moistening them with water, covering them with a piece of thin "covering glass," and then examining them with a microscope; even an ordinary pocket lens will often show these points of structure very well. Thus will the student of nature find instruction and amusement, knowledge and pastime, even in a shaving of wood cast off from a carpenter's jack-plane.

EXPLANATION OF PLATE 10.

Fig. 1. Section of oak wood cut transversely across the grain.
Fig. 2. Transverse section of sugar cane.
Both magnified 25 diameters.

NOTES ON SOME OF THE RARER BIRDS OF MASSACHUSETTS.

BY J. A. ALLEN.

(Continued from page 519.)

GOLDEN EAGLE. *Aquila chrysaëtos* Linn. (*A. Canadensis* auct.) A specimen was killed near Munson in November, 1864, and another near Deerfield, December 14th, 1865. The latter, a female, is said to have weighed thirteen and a half pounds, and to have measured seven feet and six inches in alar extent. It is now in the Springfield Museum of Natural History. Mr. J. G. Scott informs me that two specimens were captured near Westfield three years ago, one of which is in his cabinet.*

* In epist., Nov. 21, 1868.

Plate 9

Fig. 1.

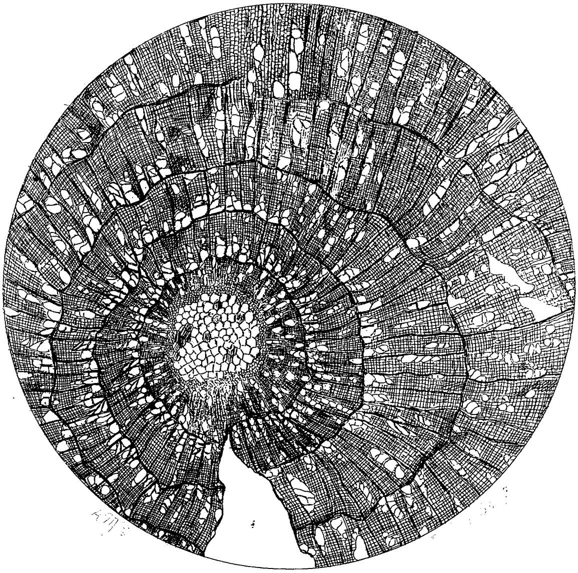

Fig. 2.